Table D.4-3. Friedman two-way analysis by ranks for density of fish larvae per 100 m^3 among sampling locations in the Potomac River and Conococheague Creek (from Ref. 1).

	Average Number of Larvae per 100 Cubic Meters (Ranked Value)						
	Transect 1			Transect 3			Conococheague Creek
Dates	0.1	0.5	0.9	0.1	0.5	0.9	
April 25-26, 1978	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)
May 3-4, 1978	0 (3.5)	0 (3.5)	0 (3.5)	0 (3.5)	1.5 (7)	0 (3.5)	0 (3.5)
May 10-11, 1978	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)
May 25-26, 1978	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)	0 (4)
June 1-2, 1978	3.3 (6)	5.6 (7)	0 (1.5)	2.5 (5)	0.8 (3)	0 (1.5)	1.2 (4)
June 9, 1978	0 (3)	0 (3)	0 (3)	0 (3)	1.4 (6)	2.4 (7)	0 (3)
ΣR_n	(24.5)	(25.5)	(20)	(23.5)	(28.0)	(24)	(22.5)

$k = 7$, $n = 6$

(1) Test statistic: $S = \{[12/nk(K+1)][\Sigma(\Sigma R_n)^2\} - 3n(k+1) = 1.321$

(2) Critical value: X^2 (0.05, K-1) = 12.592

(3) $S < X^2$; there are no significant location effects

*Stations represent approximate fractions of river width from the left shoreline, facing upstream.

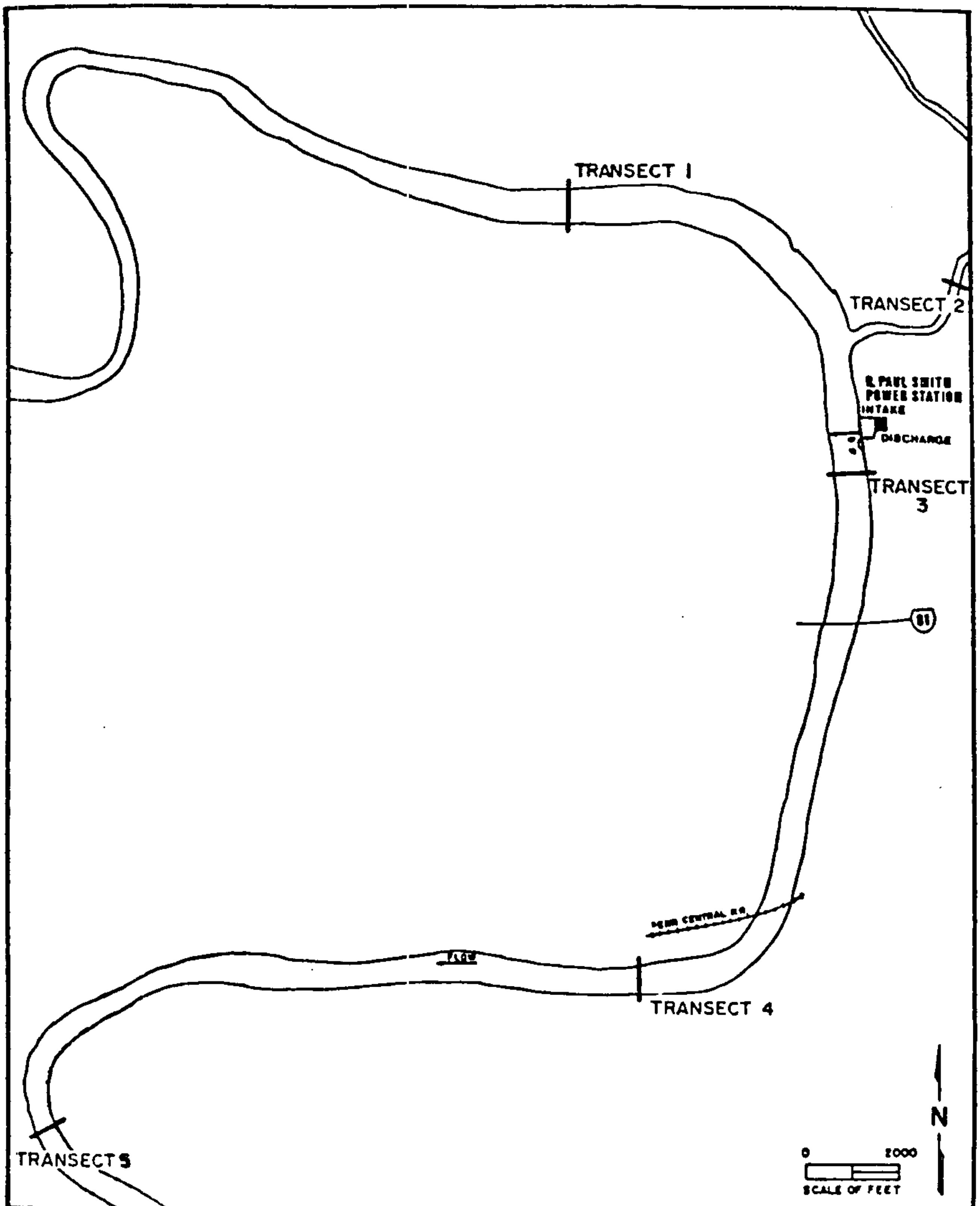

Figure D.4-1. Location of transects used for water quality and biological sampling in the vicinity of R.P. Smith power station during August 1977 and June 1978.

APPENDIX D.5. NEARFIELD FINFISH ABUNDANCE - SUMMER 1979 AND WINTER 1980

(TI)

D.5-1 Objective

To determine the spatial distribution and abundances of finfish in the vicinity of R.P. Smith Steam Electric Station during the summer of 1979 and winter of 1980.

D.5-2 Data Source

Ref. 2.

D.5-3 Study History

Finfish sampling occurred in two seasonal periods; summer, July 25 to August 8, 1979, and winter, January 15 to 28, 1980.

D.5-4 Sampling Methods

- Eight sampling transects (Fig. 1) were established in the study area; three within the plume generated by the R.P. Smith power station [discharge (T3), intermediate plume (T4), and far-field plume (T5)] and five outside the plume [two upstream (T1 and T2) and three downstream (T6, T7, and T8)]. Two sampling stations were established on opposite sides of the river at each transect for comparative purposes. The Maryland side of the Potomac River is considered the right (R) shore or bank; the West Virginia side, the left (L) shore or bank.

- Finfish were sampled on 3 nonconsecutive days during the summer of 1979 between July 25 - August 8 and on 6 nonconsecutive days during the winter of 1980 between January 15 - 28.

- Transects 1 through 5 and 8 were sampled during the summer of 1979 and Transects 1 through 7, during the winter of 1980.

- During both sampling periods, finfish were collected with a pulse dc, boat-mounted electrofishing unit.

- Electrofishing was conducted along both shores of each transect in a downstream direction along a 300-foot run (one unit of effort).

- Beach seine collections were also made along both shores at each transect. All samples were collected with a 25 x 6 ft, 1/8-in. bar mesh bag seine in areas free from underwater obstructions. At each station, seining consisted of one onshore haul; each haul was considered as one unit of effort.

- At each sampling location, temperature (OC), dissolved oxygen concentration (milligrams per liter), and stream flow (meters per second) were recorded.

- Several species of fish were selected as target species (smallmouth bass, golden redhorse, redbreast sunfish, spotfin shiner, channel catfish, and carp) because of their abundance and/or importance as a resource.

- Specimens of target species were fin-clipped differentially (right or left pelvic fin), depending on capture location (right or left bank, facing upstream), and on the anterior portion of the dorsal fin.

D.5-5 Analysis

- All fishes were identified and the number of each species in the catch determined. All target species individuals were measured for total length (millimeters) and weighed to the nearest gram up to a total of 25 individuals per species per catch. Obvious instances of parasitism/disease such as lesions, necrotic areas, attached parasites, deformation, or evidence of gas-bubble disease were noted and recorded.

- The catch-per-unit-effort (number of individuals per 300 feet of shoreline) and standard error were calculated for each station, along with the mean catch-per-unit-effort and standard error for each transect.

- Seine catch data were not considered quantitative for this study, since in uneven hardrock/rubble substrate environments, escapement under the net occurs at a variable and unquantifiable rate.

- Comparison of finfish communities along each shore and within transects (cross-stream comparison of stations) were investigated using Kendall's coefficient of concordance (W).

- Due to large numbers of tie rankings of Kendall's coefficient of concordance, W was adjusted using the following test statistic:

$$X^2 = m\,(n-1)\,W$$

where:

m = number of banks

n = number of species

W = Kendall's W.

The test statistic is approximately distributed as a chi^2 distribution with n-1 degrees of freedom.

- The only community comparisons made used the winter electrofishing data at Transects 3 through 5.

- CCNAOV (cross-classified nested analysis of variance) was used to determine the significance of effects on finfish abundance within season using the following equation:

$$Y_{ijk} = U + D_i + X_j + (XD)_{ij} + Y_k + \\ + (YD)_{ik} + (XY)_{jk} + E_{ijk}$$

where:

$i = 1, \ldots, N$	denoting the number of sampling days	N=3 summer N=6 winter
$j = 1, \ldots, M$	denoting the number of transects	M=6 summer M=7 winter
$k = 1, 2$	denoting the left or right bank	
Y	represents log (CPUE+1) of the k^{t}	

D_i	represents the effect due to sampling on the i^{th} day
X_j	represents the effect of the j^{th} day
$(XD)_{ij}$	represents the effect of the i^{th} day at transect j
Y_k	represents the effect of the k^{th} position in the river
$(YD)_{ik}$	represents the effect of the i^{th} day at position k
$(XY)_{jk}$	represents the joint effect of the j^{th} transect and the k^{th} position above and beyond the effect of each separately
E_{ijk}	represents the experimental error assumed to be normally and independently distributed with a mean of zero and a variance of σ^2.

Species-specific analyses were performed on five dominant species collected in summer and five dominant species collected in winter.

- For those species where data were too sparse to be analyzed with the CCNAOV model (i.e., carp and smallmouth bass), a Chi^2 test was used to test for the independence of transect from bank.

D.5-6 <u>Results</u>

- Temperatures observed during the electrofishing excursion in summer and winter are shown in Tables D.5-1 and D.5-2, respectively.
- A total of 26 taxa were collected by electrofishing during summer (Table D.5-3). Golden redhorse (46%), rock bass (6%), spottail shiner (6%), and spotfin shiner (6%) were the dominant species collected comprising about 64% of the average total electrofishing catch (14.72 fish per 300 feet of shore line).
- Significant differences in the total fish catch during summer due to day, bank, day-bank interactions, and transect-bank interactions were detected using the CCNAOV model (Table D.5-4).

Catches at the outfall transect (Transect 3) were significantly higher than those at Transect 2 (upstream control)(Table D.5-5). Differences between these transects appear to be the result of significantly higher catches at station 3R (heated) than 2L unheated (Table D.5-5).

- Beach seining collected 22 taxa of mostly small fish species during the summer sampling period (Table D.5-6). Catches were dominated by spotfin shiner, spottail shiner, fallfish, and unidentified cyprinids (young-of-the-year) that collectively comprised approximately 83% of the average total beach seine catch.

- Cross-river community structure comparisons at each transect within the thermal plume area (i.e., Transects 3 through 5) during the winter using Kendall's coefficient of concordance (W) indicated similar communities at Transect 5 only (Table D.5-7). The primary differences between the stations at Transects 3 and 4 were lower catches along the West Virginia shore (unheated). No similar comparisons were made for the summer period due to the high incidence of zero catches.

- During winter, a total of 23 fish taxa were collected by electrofishing (Table D.5-8). Golden redhorse (63%), carp (8%), and smallmouth bass (5%) comprised about 76% of the average total electrofishing catch (5.56 fish/sample).

- Using the CCNAOV model and Duncan's Multiple Range test, most fish (total fish catch) in the R.P. Smith plant vicinity were found along the Maryland shore at Transects 3 and 4 in winter (Tables D.5-9 and D.5-10).

- During winter a total of 12 taxa were captured by beach seine. These species were captured in low abundance at most sampling locations (Table D.5-11). Spotfin shiner, bluntnose minnow, and comely shiner were the most abundant species collected.

- Mark-recapture studies during summer and winter indicated that the movements of the golden redhorse and smallmouth bass were restricted to the location of initial capture. During summer, three golden redhorse were collected, marked, and recaptured along the West Virginia shore and three along the Maryland shore. Of the 143 golden redhorse marked during winter, all 6 recaptures were taken along the shore of initial capture. For the smallmouth bass, one fish was marked and recaptured along the right bank during summer and another during winter. The other five target species (spotfin shiner, redbreast sunfish, channel catfish, carp, and shorthead redhorse) were either not marked or marked fish were not recaptured.

- No evidence of disease, parasites, or malformations was found on any of the redbreast sunfish, spotfin shiner, carp, or shorthead redhorse examined during the two study periods. Disease/parasitism was not obvious in the golden redhorse or smallmouth bass during the summer, but was found in winter for both species. During winter, six golden redhorse were collected that were either malformed by scoliosis (n=2), parasitized (n=3), or diseased (n=4). All but one of these fish were collected along the Maryland shore, two each at Transects 3 and 4, and one at Transect 5. The other was collected along the West Virginia shore at Transect 7. Parasites (leeches) were found on one smallmouth bass collected during the winter at Transect 4 along the Maryland shore. During summer, four channel catfish were parasitized by leeches. During winter, a single channel catfish collected at the outfall station was parasitized by leeches and had open lesions possibly resulting from a bacterial infection.

- Golden redhorse was the dominant fish collected by electrofishing during summer and winter and represented over 48% of the total average catch during each season. Significant differences ($p < 0.05$) in catches of golden redhorse during the summer were due to date of capture and transect (Table D.5-12). No differences resulted from transect or bank effects as determined by Duncan's Multiple Range Test (Table D.5-13).

- During winter, golden redhorse were significantly more abundant at the outfall station (Maryland shore, Transect 3) and the station along the Maryland shore at Transect 4 than at other sampling locations (Tables D.5-14 and D.5-15).

- Spotfin shiner was the most abundant species collected by beach seine during both summer and winter and represented about 3 - 6% of the total average electrofishing catch. Beach seine catches during summer and winter were usually higher along the Maryland shore within the thermally affected area (Transect 3 - summer, Transects 3 and 4 - winter) than along the opposite shore. During summer, higher catches of spotfin shiner were collected at the thermally affected stations (i.e., Maryland shore, Transects 3 and 4) by electrofishing, but none were collected at these two locations during winter.

- Smallmouth bass constituted about 4 and 6% respectively of the summer and winter electrofishing catch. Although catches were low, smallmouth bass were collected during both summer and winter by beach seine. Electrofishing catches during summer were variable and showed no evident spatial pattern of abundance. Catches during winter were higher at thermally influenced stations than at other sampling locations but this difference could not be statistically tested with the CCNAOV model since there was a large number of no-catches. Chi^2 analysis did not provide any additional information (i.e., low cell counts made analysis unreliable).

- Redbreast sunfish were collected only by electrofishing and constituted 4% of the total average catch during summer and winter. No definite spatial abundance pattern was evident from summer and winter results but this species appeared to be more abundant in the thermal plume during winter. Chi^2 analyses did not provide any additional information (i.e., low cell counts made analysis unreliable).

- Channel catfish were most abundant during the summer sampling period when they constituted 5% of the total average electrofishing catch. Data were too sparse to test statistically.

- Carp were more abundant during winter than summer, constituting 8 and 3% of the total electrofishing catch, respectively. Carp were distributed over most of the study area during summer but were collected during winter only at the two stations most influenced by the thermal discharge.

- Shorthead redhorse were collected only during winter by electrofishing and these were most abundant in the areas most influenced by the thermal plume. Shorthead redhorse abundance was too sparse to be tested statistically.

D.5-7 Significance and Critique of Findings

- Due to an unannounced shutdown, plant load during the summer season was at less than 30% capacity. Thermal discharge was limited primarily to the area of the outfall (3R) and/or the nearest station downstream (4R). The largest number of fish taxa (18 of 26 taxa) were collected at the outfall (3R) as were the largest catches. The only station that had a significantly lower catch than station 3R (Transect 3, Maryland shore) was station 2L (Transect 2, West Virginia shore).

- The summer data (1979) are inconclusive in demonstrating an effect of power plant operations on finfish abundance and/or vitality. The observed differences between stations (total catch, disease, or parasitism) could be attributed to natural habitat differences.

- Golden redhorse, smallmouth bass, carp, redbreast sunfish, and shorthead redhorse are attracted to the warmer plume areas during the winter. The largest ΔT's during winter were recorded at the plant outfall and downstream along the Maryland shore at Transect 4. Catches were significantly higher at these stations during winter than at all other stations sampled during this period. Across-river community comparisons at each transect within the thermally influenced portion of the study area (Transects 3 and 4) indicate dissimilar communities.

- The limited mark-recapture survey indicated no finfish migration across the river.

- During winter, the golden redhorse, the dominant species collected in the R.P. Smith study area during summer and winter 1979-80, was significantly more abundant at Transects 3 and 4 (heated) than other sampling locations. There was also a higher incidence of disease/parasitism for golden redhorse found inside the thermal plume area than those found outside. These differences may have been due to thermal discharge. However, the number of samples is too little to demonstrate this relationship conclusively.

Table D.5-1. Potomac River water temperature (C) measured during electrofishing excursions, R.P. Smith SES, July - August 1979 (data from Ref. 2).

Date	1L	1R	2L	2R	3L	3R	4L	4R	5L	5R	8L	8R
7/30	24.0	24.0	24.0	24.0	26.0	28.0	26.0	28.5	26.0	26.0	26.0	27.0
8/3	28.5	28.5	27.5	27.5	25.9	31.5	26.1	31.5	26.5	26.5	27.8	28.8
8/6	29.0	29.0	29.0	29.0	29.2	34.5	27.5	32.0	28.0	28.0	29.0	31.0

Table D.5-2. Potomac River water temperature (C) measured during electrofishing excursions, R.P. Smith SES, January 1980 (data from Ref. 2).

Date	1L	1R	2L	2R	3L	3R	4L	4R	5L	5R	6L	6R	7L	7R
1/18	4.1	4.0	4.1	4.1	4.1	9.8	4.1	6.5	4.1	5.2	4.1	4.7	4.0	4.5
1/20	3.9	4.0	4.1	4.0	4.1	7.9	4.3	5.8	4.0	5.0	4.1	4.1	4.0	4.3
1/22	3.1	3.0	3.1	3.1	3.1	8.0	3.2	5.2	4.1	4.1	4.1	4.2	3.9	4.0
1/24	0.8	2.0	1.9	2.0	2.0	8.2	2.0	4.9	2.0	3.0	2.0	2.2	2.0	2.2
1/26	0.9	1.0	0.9	1.0	0.9	11.8	0.8	7.1	1.0	4.0	2.1	1.8	1.5	2.1
1/28	0.7	0.8	0.8	0.9	1.0	10.8	1.2	8.6	1.2	5.0	2.8	1.8	1.6	2.8

Table D.5-3. Mean catch per unit effort for fishes collected by electrofishing in the vicinity of R.P. Smith power station during July-August 1979 (from Ref. 2).

NAME	X1_L	X1_R	X2_L	X2_R	X3_L	X3_R	X4_L	X4_R	X5_L	X5_R	X6_L	X6_R
AMERICAN EEL	0.33	.	.	.	.	.	.	.	0.33	.	.	.
GOLDFISH	.	.	.	.	.	.	.	0.67	.	.	.	.
CARP	0.33	0.33	0.33	0.33	0.67	0.67	0.33	1.33	0.33	.	1.00	0.33
RIVER CHUB	.	.	.	.	1.67	.	1.00	.	.	.	.	.
GOLDEN SHINER	.	.	.	.	.	.	.	0.33	.	.	.	.
SPOTTAIL SHINER	.	.	.	1.00	.	8.67	.	.	0.33	.	.	0.33
SPOTFIN SHINER	.	.	.	.	.	1.33	1.67	3.00	1.00	.	1.00	1.67
BLUNTNOSE MINNOW	.	.	.	.	.	2.67	.	.	.	.	.	.
FALLFISH	.	.	.	3.00	.	.	.	0.67	.	.	.	.
CYPRINIDAE-MINNOWS AND CARPS(LPI	.	.	.	.	.	.	.	.	.	0.33	.	.
WHITE SUCKER	.	.	.	.	.	.	.	.	.	0.33	.	.
NORTHERN HOGSUCKER	0.33	1.33	.	0.33	1.33	.	.	.	.	.	.	.
GOLDEN REDHORSE	8.00	4.67	0.33	3.00	8.67	23.67	5.00	4.33	12.33	6.67	2.67	2.33
WHITE CATFISH	.	.	.	.	0.33	.	.	.	.	.	.	.
YELLOW BULLHEAD	.	.	.	0.33	0.33	.	0.33	0.33	.	.	.	0.33
CHANNEL CATFISH	0.67	1.00	.	0.67	0.33	1.67	.	.	2.67	.	0.67	0.67
ROCK BASS	.	4.33	0.33	2.00	0.33	.	.	1.00	0.67	0.67	1.33	0.33
REDBREAST SUNFISH	.	1.33	.	1.33	0.67	.	0.33	0.33	.	.	2.33	0.67
GREEN SUNFISH	.	.	0.33	.	.	0.33	.	1.33	.	1.00	0.33	1.00
PUMPKINSEED	.	.	.	.	2.33	0.67	0.33	0.33	.	0.33	0.33	0.67
LEPOMIS SPP (LPIL)	0.33	.	0.33	.	1.33	0.33	.	0.67	.	0.33	0.67	0.67
BLUEGILL	.	.	.	.	1.33	.	.	.	.	0.33	0.33	.
LONGEAR SUNFISH	.	.	.	0.67	.	.	.	.	0.33	.	0.33	.
LEPOMIS SPP (LPIL)	.	.	.	.	1.00	.	.	.	.	.	.	0.67
SMALLMOUTH BASS	.	1.00	.	0.67	.	0.33	.	1.67	1.00	0.33	0.67	0.67
CENTRARCHIDAE-SUNFISHES (LPIL)	.	.	0.33	.	.	.	.	.	.	.	.	.
YELLOW PERCH	.	.	.	0.33	.	.	.	.	.	.	.	.
TOTAL	10.00	14.00	2.00	13.67	20.33	40.33	9.00	16.00	19.00	10.33	11.67	10.33

NAME	GC	SITEMEAN	REL_ABUN
AMERICAN EEL	40	0.06	0.4
GOLDFISH	40	0.06	0.4
CARP	40	0.50	3.4
RIVER CHUB	40	0.22	1.5
GOLDEN SHINER	40	0.03	0.2
SPOTTAIL SHINER	40	0.86	5.8
SPOTFIN SHINER	40	0.81	5.5
BLUNTNOSE MINNOW	40	0.22	1.5
FALLFISH	40	0.31	2.1
CYPRINIDAE-MINNOWS AND CARPS(LPI	40	0.03	0.2
WHITE SUCKER	40	0.03	0.2
NORTHERN HOGSUCKER	40	0.28	1.9
GOLDEN REDHORSE	40	6.81	46.2
WHITE CATFISH	40	0.03	0.2
YELLOW BULLHEAD	40	0.14	0.9
CHANNEL CATFISH	40	0.69	4.7
ROCK BASS	40	0.92	6.2
REDBREAST SUNFISH	40	0.58	4.0
GREEN SUNFISH	40	0.36	2.5
PUMPKINSEED	40	0.42	2.8
LEPOMIS SPP (LPIL)	40	0.39	2.6
BLUEGILL	40	0.17	1.1
LONGEAR SUNFISH	40	0.11	0.8
LEPOMIS SPP (LPIL)	40	0.14	0.9
SMALLMOUTH BASS	40	0.53	3.6
CENTRARCHIDAE-SUNFISHES (LPIL)	40	0.03	0.2
YELLOW PERCH	40	0.03	0.2
	40	14.72	100.0

Table D.5-4. CCNAOV and multiple comparisons for total finfish catch (summer)(from Ref. 2).

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LOGTOT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	25	21.00684270	0.84027371	4.03	0.0129	0.909670	18.5020
ERROR	10	2.08598298	0.20859830		STD DEV		LOGTOT MEAN
CORRECTED TOTAL	35	23.09282568			0.45672563		2.46851398

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
DAY	2	0.74894233	1.80	0.2157	2	0.74894233	1.80	0.2157
X	5	8.14859063	7.81	0.0031	5	8.14859063	7.81	0.0031
DAY*X	10	7.75899890	3.72	0.0249	10	7.75899890	3.72	0.0249
Y	1	0.76075065	3.65	0.0852	1	0.76075065	3.65	0.0852
DAY*Y	2	0.58717492	1.41	0.2894	2	0.58717492	1.41	0.2894
X*Y	5	3.00238527	2.88	0.0728	5	3.00238527	2.88	0.0728

TESTS OF HYPOTHESES USING THE TYPE IV MS FOR DAY*X AS AN ERROR TERM

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
X	5	8.14859063	2.10	0.1488

TESTS OF HYPOTHESES USING THE TYPE IV MS FOR DAY*Y AS AN ERROR TERM

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
Y	1	0.76075065	2.59	0.2487

Table D.5-5. Duncan's multiple range test for total finfish abundance by (a) transect, (b) bank, and (c) transect-bank combinations (from Ref. 2).

(a)

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=10 MS=0.7759

GROUPING		MEAN	N	X
	A	3.251422	6	3
	A			
B	A	2.682662	6	5
B	A			
B	A	2.505903	6	4
B	A			
B	A	2.447447	6	8
B	A			
B	A	2.265128	6	1
B				
B		1.658522	6	2

(b)

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=2 MS=0.29059

GROUPING	MEAN	N	Y
A	2.613832	18	3
A			
A	2.323146	18	1

(c)

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=10 MS=0.2086

GROUPING		MEAN	N	X	Y
	A	3.539845	3	3	3
	A				
B	A	2.970195	3	5	1
B	A				
B	A	2.963378	3	3	1
B	A				
B	A	2.819723	3	4	3
B					
B		2.511596	3	8	1
B					
B		2.395129	3	5	3
B					
B		2.393306	3	8	3
B					
B		2.298978	3	1	3
B					
B		2.257693	3	2	3
B					
B		2.241577	3	1	1
B					
B		2.195084	3	4	1
	C	1.055551	3	2	1

Table D.5-6. Mean catch per unit effort for fishes collected by beach seining during July-August (from Ref. 2).

NAME	X1_L	X1_R	X2_L	X2_R	X3_L	X3_R	X4_L	X4_R	X5_L	X5_R
STONEROLLER	.	0.33	.	.	.	1.00	.	.	.	.
GOLDEN SHINER	.	.	.	.	1.00	.	.	.	.	.
COMMON SHINER	.	.	0.33	.	.	0.33	.	.	0.33	.
PUGNOSE MINNOW	.	.	.	.	.	0.33	.	.	.	.
SPOTTAIL SHINER	1.67	4.33	2.00	1.33	2.67	1.33	.	.	1.67	2.67
SPOTFIN SHINER	16.33	8.00	6.33	2.00	5.67	6.67	3.33	1.00	6.00	9.00
BLUNTNOSE MINNOW	.	.	.	0.33	2.00	1.67	.	.	.	.
FALLFISH	2.00	4.00	.	.	1.00	2.00	.	0.33	1.33	.
CYPRINIDAE-MINNOWS AND CARPS(LPI	0.33	.	9.33	.	.	.	.	.	.	.
NORTHERN HOGSUCKER	.	.	.	.	.	.	0.33	.	.	.
MOXOSTOMA SPP (LPIL)	.	.	.	0.33	.	1.00	.	.	.	.
ROCK BASS	.	.	.	.	.	.	.	.	.	0.33
GREEN SUNFISH	.	.	0.67	.	0.33	.	.	.	.	0.67
PUMPKINSEED	.	.	.	.	.	.	.	.	.	0.67
LEPOMIS SPP (LPIL)	.	.	.	.	.	.	.	.	.	1.00
BLUEGILL	.	.	.	.	.	.	.	.	.	0.33
LONGEAR SUNFISH	.	0.33	0.33	0.33	0.33	.	.	.	0.33	.
SMALLMOUTH BASS	.	.	.	.	.	0.33	0.33	.	.	.
LARGEMOUTH BASS	.	.	.	.	.	0.33	.	.	.	.
GREENSIDE DARTER	.	.	.	.	.	1.00	.	0.33	.	.
TESSELLATED DARTER	.	0.33	0.67	.	.	1.00	0.67	.	.	.
YELLOW PERCH	.	.	.	.	0.33	.	.	.	.	.
TOTAL	20.33	17.33	19.67	4.33	13.33	17.00	4.67	1.67	9.67	14.67

NAME	GC	SITEMEAN	REL_ABUN
STONEROLLER	30	0.13	1.1
GOLDEN SHINER	30	0.10	0.8
COMMON SHINER	30	0.10	0.8
PUGNOSE MINNOW	30	0.03	0.3
SPOTTAIL SHINER	30	1.77	14.4
SPOTFIN SHINER	30	6.43	52.4
BLUNTNOSE MINNOW	30	0.40	3.3
FALLFISH	30	1.07	8.7
CYPRINIDAE-MINNOWS AND CARPS(LPI	30	0.97	7.9
NORTHERN HOGSUCKER	30	0.03	0.3
MOXOSTOMA SPP (LPIL)	30	0.13	1.1
ROCK BASS	30	0.03	0.3
GREEN SUNFISH	30	0.17	1.4
PUMPKINSEED	30	0.07	0.5
LEPOMIS SPP (LPIL)	30	0.10	0.8
BLUEGILL	30	0.03	0.3
LONGEAR SUNFISH	30	0.17	1.4
SMALLMOUTH BASS	30	0.07	0.5
LARGEMOUTH BASS	30	0.03	0.3
GREENSIDE DARTER	30	0.13	1.1
TESSELLATED DARTER	30	0.27	2.2
YELLOW PERCH	30	0.03	0.3
	30	12.27	100.0

Table D.5-7. Community comparisons of left and right banks for Transects 3, 4, and 5 for winter electrofishing catch using Kendall's coefficient of concordance W (from Ref. 2).

Transect	W	F	DF1	DF2	PROB
3	0.613892	1.58995	13	13	0.207110
4	0.492957	0.97222	14	14	0.520646
5	0.848911	5.61863	5	5	0.040634

Table D.5-8. Mean catch per unit effort for fishes collected by electrofishing in January 1980 (from Ref. 2).

NAME	X1_L	X1_R	X2_L	X2_R	X3_L	X3_R	X4_L	X4_R	X5_L	X5_R	X6_L	X6_R	X7_L	X7_R
AMERICAN EEL	.	.	.	.	.	.	.	.	.	.	.	.	.	0.33
GOLDFISH	.	.	.	.	.	0.17	.	0.17	.	.	.	.	.	.
CARP	.	.	0.17	1.17	.	1.17	.	2.17	.	0.17	0.17	.	0.83	0.33
GOLDEN SHINER	.	.	.	.	.	.	.	0.33	.	.	.	.	.	.
EMERALD SHINER	.	0.17	0.83	.	0.17	1.17	.	.	.	.	.	.	.	.
SPOTTAIL SHINER	.	.	.	.	.	0.17	0.17	.	.	0.17	.	.	.	.
BLUNTNOSE MINNOW	.	.	.	0.17	.	.	0.17	.	.	0.50	.	.	.	.
SPOTFIN SHINER	0.33	0.17	.	0.33	0.33	.	0.17	.	0.33	0.33	.	.	.	0.33
FALLFISH	.	.	.	.	.	.	.	0.17	.	.	.	.	.	.
PEARL DACE	.	.	.	0.17	.	0.17	.	0.17	.	0.17	.	.	.	.
WHITE SUCKER	.	.	.	.	.	.	.	.	.	.	0.17	.	.	0.67
CREEK CHUBSUCKER	.	.	.	.	.	.	.	.	.	.	.	0.17	.	.
GOLDEN REDHORSE	1.17	0.17	0.33	1.83	0.17	14.33	0.33	16.00	0.33	2.67	2.17	2.17	2.00	5.50
SHORTHEAD REDHORSE	0.17	.	.	.	.	1.00	.	1.67	.	0.17	.	.	.	0.17
YELLOW BULLHEAD	.	.	.	0.17	.	.	.	0.17	.	.	.	.	.	.
BROWN BULLHEAD	.	.	.	0.17	.	.	.	.	.	.	.	.	.	.
CHANNEL CATFISH	.	.	.	0.17	.	0.17	.	.	.	.	.	.	.	.
ROCK BASS	.	.	.	.	.	0.50	0.17	0.50	.	.	.	0.17	.	.
REDBREAST SUNFISH	.	.	.	.	.	0.17	.	2.33	.	.	.	0.17	.	0.67
PUMPKINSEED	.	.	.	.	.	0.17	.	0.17	.	.	.	.	.	0.17
SMALLMOUTH BASS	.	.	.	0.17	0.17	0.83	0.33	1.67	.	.	0.17	0.33	0.17	0.17
LARGEMOUTH BASS	.	.	.	.	.	0.17	.	0.17	.	.	.	.	.	.
YELLOW PERCH	.	.	.	.	.	0.17	.	.	.	.	.	.	.	.
TOTAL	1.67	0.50	1.33	4.33	0.83	20.33	1.33	25.67	0.67	4.17	2.67	3.00	3.00	8.33

NAME	SC	SITEMEAN	REL_ABUN
AMERICAN EEL	40	0.02	0.4
GOLDFISH	40	0.02	0.4
CARP	40	0.44	7.9
GOLDEN SHINER	40	0.02	0.4
EMERALD SHINER	40	0.17	3.0
SPOTTAIL SHINER	40	0.04	0.6
BLUNTNOSE MINNOW	40	0.06	1.1
SPOTFIN SHINER	40	0.17	3.0
FALLFISH	40	0.01	0.2
PEARL DACE	40	0.05	0.9
WHITE SUCKER	40	0.06	1.1
CREEK CHUBSUCKER	40	0.01	0.2
GOLDEN REDHORSE	40	3.51	63.2
SHORTHEAD REDHORSE	40	0.23	4.1
YELLOW BULLHEAD	40	0.02	0.4
BROWN BULLHEAD	40	0.01	0.2
CHANNEL CATFISH	40	0.02	0.4
ROCK BASS	40	0.10	1.7
REDBREAST SUNFISH	40	0.24	4.3
PUMPKINSEED	40	0.04	0.6
SMALLMOUTH BASS	40	0.29	5.1
LARGEMOUTH BASS	40	0.02	0.4
YELLOW PERCH	40	0.01	0.2
	40	5.56	100.0

Table D.5-9. CCNAOV and multiple comparisons for total catch (winter)(from Ref. 2).

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LOGTOT

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	91.11417193	1.71913532	6.38	0.0001	0.918544	41.5781
ERROR	30	8.07997519	0.26933251		STD DEV		LOGTOT MEAN
CORRECTED TOTAL	83	99.19414712			0.51897255		1.24818689

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
DAY	5	16.61640449	12.34	0.0001	5	16.61640449	12.34	0.0001
Y	6	20.11440290	12.45	0.0001	6	20.11440290	12.45	0.0001
DAY*Y	30	8.40523169	1.04	0.4573	30	8.40523169	1.04	0.4573
[illegible]	1	23.30461042	86.53	0.0001	1	23.30461042	86.53	0.0001
[illegible]	5	1.44653779	1.07	0.3943	5	1.44653779	1.07	0.3943
[illegible]	6	21.22698465	13.14	0.0001	6	21.22698465	13.14	0.0001

TESTS OF HYPOTHESES USING THE TYPE IV MS FOR DAY*Y AS AN ERROR TERM

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
[illegible]	6	20.11440290	11.97	0.0001

TESTS OF HYPOTHESES USING THE TYPE IV MS FOR DAY*Y AS AN ERROR TERM

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
[illegible]	1	23.30461042	80.55	0.0003

Table D.5-10. Duncan's multiple range test for total finfish abundance in winter by (a) transect, (b) bank, and (c) combination of transect and bank (from Ref. 2).

(a) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=30 MS=0.28017

GROUPING	MEAN	N	X
A	1.974124	12	4
A			
A	1.745292	12	3
A			
A	1.574888	12	7
B	1.077947	12	6
B			
B	0.971202	12	2
B			
C B	0.899262	12	5
C			
C	0.494575	12	1

(b) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=5 MS=0.2893

GROUPING	MEAN	N	Y
A	1.774909	42	3
B	0.721465	42	1

(c) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=30 MS=0.26933

GROUPING	MEAN	N	X	Y
A	3.235470	6	4	3
A				
A	2.960908	6	3	3
B	2.005287	6	7	3
B				
C B	1.432259	6	5	3
C				
C D	1.327591	6	2	3
C D				
C D E	1.164119	6	6	3
C D E				
C D E	1.144459	6	7	1
C D E				
C F D E	0.991774	6	6	1
F D E				
F D E	0.712778	6	4	1
F D E				
F D E	0.690522	6	1	1
F E				
F E	0.614813	6	2	1
F E				
F E	0.529676	6	3	1
F				
F	0.366204	6	5	1
F				
F	0.299627	6	1	3

Table D.5-11. Mean catch per unit effort for fishes collected by beach seine in the vicinity of R.P. Smith power station during January 1980 (from Ref. 2).

NAME	X1_L	X1_R	X2_L	X2_R	X3_L	X3_R	X4_L	X4_R	X5_L	X5_R	X6_L	X6_R	X7_L	X7_R	X8_L	X8_R
COMELY SHINER	1.00	.	0.33	0.33	.	.	.	.	.	0.17	.	0.17	2.67	0.33	.	.
EMERALD SHINER	.	.	.	.	0.17	.	.	.	.	.	.	.	.	.	.	.
SPOTTAIL SHINER	0.17	0.50	0.17	.	.	.	.	.	.	.	.	.	.	.	.	.
BLUNTNOSE MINNOW	1.33	0.50	1.17	2.83	.	.	1.67	0.50	0.17	0.83	0.17	0.17	1.67	2.67	0.67	1.33
SPOTFIN SHINER	7.17	16.67	2.17	1.33	.	1.67	0.67	2.17	1.00	0.33	3.33	0.17	13.17	0.83	0.67	2.33
SHINER LPIL	.	0.33	.	.	.	.	.	.	.	.	.	.	1.67	.	.	0.33
FATHEAD MINNOW	.	.	.	.	.	.	0.33	.	.	.	.	.	.	.	.	.
GOLDEN REDHORSE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.33
BANDED KILLIFISH	.	.	.	.	.	0.17	.	.	.	.	.	.	0.17	.	.	0.33
LEPOMIS SPP (LPIL)	.	.	.	.	.	.	.	.	.	0.17	0.17	.	.	.	.	.
SMALLMOUTH BASS	.	.	.	.	.	.	.	0.17	.	.	.	.	.	.	.	.
TESSELLATED DARTER	.	.	.	.	.	.	.	0.33	.	.	.	0.50	.	0.50	.	.
TOTAL	9.67	18.00	3.83	4.50	0.17	1.83	2.67	3.17	1.17	1.50	3.67	1.00	19.33	4.33	1.33	4.67

NAME	GC	SITEMEAN	REL_ABUN
COMELY SHINER	30	0.33	6.4
EMERALD SHINER	30	0.01	0.2
SPOTTAIL SHINER	30	0.06	1.1
BLUNTNOSE MINNOW	30	0.98	18.9
SPOTFIN SHINER	30	3.48	67.0
SHINER LPIL	30	0.14	2.8
FATHEAD MINNOW	30	0.02	0.4
GOLDEN REDHORSE	30	0.01	0.2
BANDED KILLIFISH	30	0.03	0.6
LEPOMIS SPP (LPIL)	30	0.02	0.4
SMALLMOUTH BASS	30	0.01	0.2
TESSELLATED DARTER	30	0.09	1.7
	30	5.19	100.0

Table D.5-12. CCNAOV and multiple comparisons for golden redhorse (summer)(from Ref. 2).

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	25	30.18451660	1.20738066	2.36	0.0788	0.854957	46.8161
ERROR	10	5.12077547	0.51207755		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	35	35.30529207			0.71559594		1.52852450

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
DAY	2	5.85527145	5.72	0.0221	2	5.85527145	5.72	0.0221
X	5	9.42894853	3.68	0.0377	5	9.42894853	3.68	0.0377
DAY*X	10	11.72692922	2.29	0.1037	10	11.72692922	2.29	0.1037
Y	1	0.18409691	0.36	0.5621	1	0.18409691	0.36	0.5621
DAY*Y	2	0.04252851	0.04	0.9595	2	0.04252851	0.04	0.9595
X*Y	5	2.94674198	1.15	0.3959	5	2.94674198	1.15	0.3959

TESTS OF HYPOTHESES USING THE TYPE IV MS FOR DAY*X AS AN ERROR TERM

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
X	5	9.42894853	1.61	0.2442

TESTS OF HYPOTHESES USING THE TYPE IV MS FOR DAY*Y AS AN ERROR TERM

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
Y	1	0.18409691	8.66	0.0967

Table D.5-13. Duncan's multiple range test for golden redhorse abundance in summer for (a) transect, (b) bank, and (c) transect-bank combination.

(a) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=10 MS=1.17269

GROUPING	MEAN	N	X
A	2.224420	6	5
A			
A	1.935853	6	3
A			
A	1.697232	6	1
A			
A	1.563769	6	4
A			
A	1.011404	6	8
A			
A	0.739469	6	2

(b) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=2 MS=.0212643

GROUPING	MEAN	N	Y
A	1.600035	18	1
A			
A	1.457014	18	3

(c) MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=10 MS=0.51208

GROUPING			MEAN	N	X	Y
	A		2.509302	3	5	1
	A					
B	A		2.219765	3	3	1
B	A					
B	A		2.013418	3	1	1
B	A					
B	A		1.939037	3	5	3
B	A					
B	A	C	1.651942	3	3	3
B	A	C				
B	A	C	1.556827	3	4	1
B	A	C				
B	A	C	1.560710	3	4	3
B	A	C				
B	A	C	1.381045	3	1	3
B	A	C				
B	A	C	1.245890	3	2	3
B	A	C				
B	A	C	1.059351	3	8	1
B		C				
B		C	0.963457	3	8	3
		C				
		C	0.231049	3	2	1

Table D.5-14. CCNAOV and multiple comparisons for golden redhorse (winter)(from Ref. 2).

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LOGDENS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	53	77.76447913	1.46725432	4.14	0.0001	0.879666	66.8148
ERROR	30	10.63779355	0.35459312		STD DEV		LOGDENS MEAN
CORRECTED TOTAL	83	88.40227268			0.59547722		0.89123484

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
DAY	5	13.39454224	7.55	0.0001	5	13.39454224	7.55	0.0001
X	6	14.62149240	6.87	0.0001	6	14.62149240	6.87	0.0001
DAY*X	30	7.36178112	0.69	0.8406	30	7.36178112	0.69	0.8406
Y	1	16.81744770	47.43	0.0001	1	16.81744770	47.43	0.0001
DAY*Y	5	1.82777951	1.03	0.4175	5	1.82777951	1.03	0.4175
X*Y	6	23.74143616	11.16	0.0001	6	23.74143616	11.16	0.0001

TESTS OF HYPOTHESES USING THE TYPE IV MS FOR DAY*X AS AN ERROR TERM

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
X	6	14.62149240	9.93	0.0001

TESTS OF HYPOTHESES USING THE TYPE IV MS FOR DAY*Y AS AN ERROR TERM

SOURCE	DF	TYPE IV SS	F VALUE	PR > F
Y	1	16.81744770	46.01	0.0011

Table D.5-15. Duncan's multiple range test for golden redhorse in winter by (a) transect, (b) bank, and (c) transect-bank combinations (from Ref. 2).

(a)

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=30 MS=0.245393

GROUPING			MEAN	N	X
		A	1.476904	12	4
		A			
		A	1.355744	12	3
		A			
B		A	1.123709	12	7
B					
B	C		0.902312	12	6
	C				
D	C		0.606033	12	5
D	C				
D	C		0.475315	12	2
D					
D			0.298627	12	1

(b)

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=5 MS=0.365556

GROUPING	MEAN	N	Y
A	1.338631	42	3
B	0.443789	42	1

(c)

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=30 MS=0.35459

GROUPING			MEAN	N	X	Y
	A		2.722759	6	4	3
	A					
	A		2.595963	6	3	3
	B		1.236787	6	7	3
	B					
C	B		0.991017	6	5	3
C	B					
C	B		0.950630	6	7	1
C	B					
C	B	D	0.912440	6	6	1
C	B	D				
C	B	D	0.821195	6	6	3
C	B	D				
C	B	D	0.767528	6	2	3
C		D				
C		D	0.481729	6	1	1
C		D				
C		D	0.231049	6	5	1
C		D				
C		D	0.231049	6	4	1
C		D				
C		D	0.183102	6	2	1
		D				
		D	0.115525	6	1	3
		D				
		D	0.115525	6	3	1

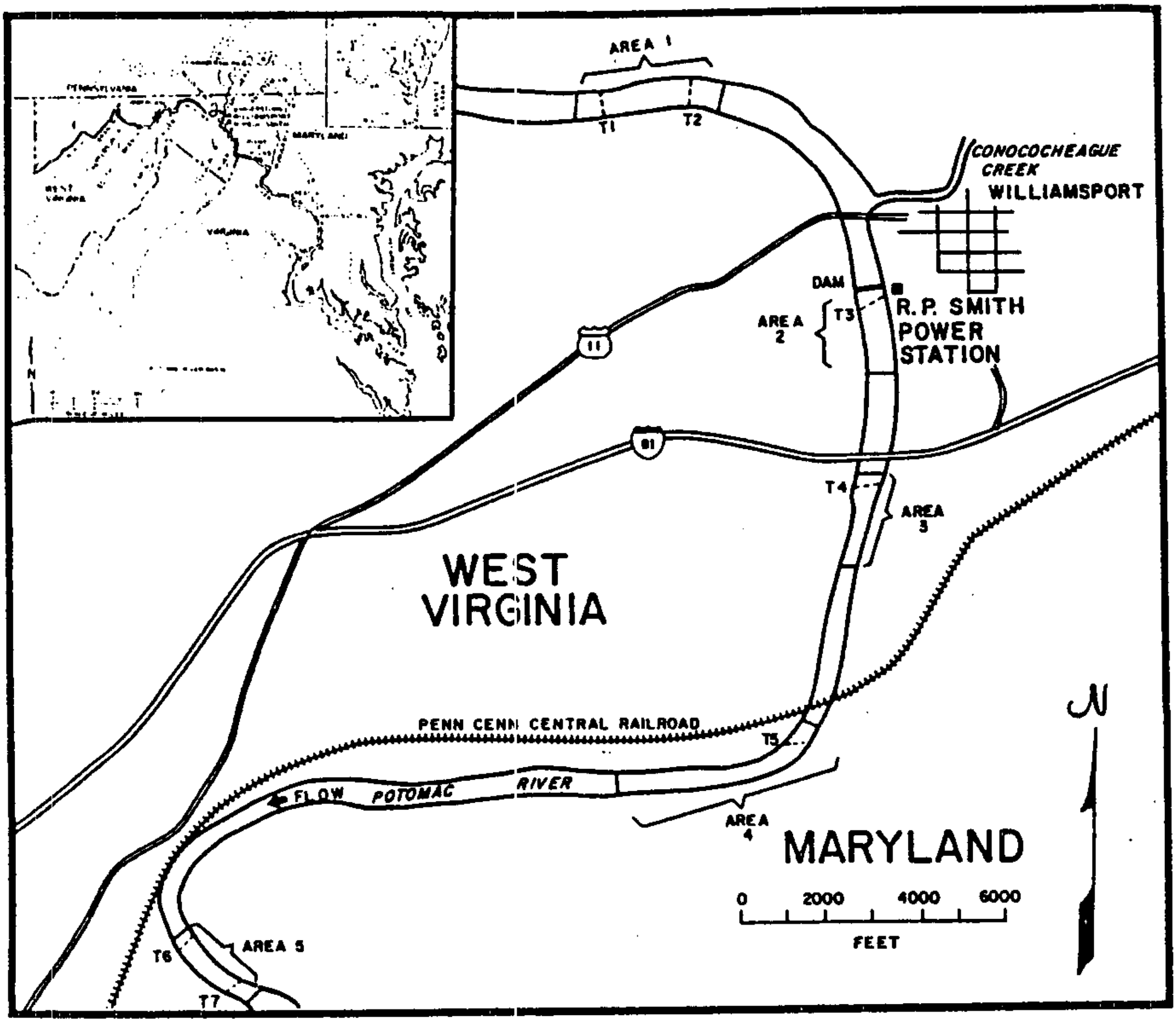

Figure D.5-1. Locations of sampling areas and transects for biological sampling in the vicinity of R.P. Smith power station (from Ref. 2).

APPENDIX D.6. WINTER FINFISH SURVEY

(MDNR)

D.6-1. Objective

To evaluate the impact of heated discharge from the R.P. Smith SES on the winter finfish community in the vicinity of the plant.

D.6-2. Data Source

Ref. 9.

D.6-3. Study History

Sampling was conducted during February and March 1979.

D.6-4. Sampling Methods

Winter finfish sampling was conducted on two dates (February 23 and March 16) in the winter of 1979. Electroshock sampling, using a 240-volt AC generator, was conducted at three transects with two stations (opposite banks) at each transect. Transect 1 extended approximately 400 feet downstream of the R.P. Smith discharge outlet, Transect 2 was approximately 1,300 feet downstream, and Transect 3 was approximately 4,000 feet downstream. The designations MD (Maryland) and WVA (West Virginia) refer to the specific shoreline sampled. A fifteen-minute sampling run was conducted at each station. Ten randomly selected representatives of each species (all specimens if less than ten were present) were measured and weighed. All specimens were counted. In addition, dissolved oxygen and water temperature were measured at each station on each date.

D.6-5. Analyses

- Total catch and mean length and mean weight by species were listed for each station.
- The Bray-Curtis Index of sample similarity was computed and a cluster analysis of these similarity indices was done by Energy Impact Associates (Appendix D.2) for the February 23, 1979 samples.
- The Mann-Whitney Test was used to determine potential differences in total catch among stations (Appendix D.2).

D.6-6. Results

- The R.P. Smith heated discharge attracted fish on both sampling dates though the phenomenon was more pronounced in February (Table D.6-1; Tables D.2-19, D.2-20, and Figure D.2-4).

- Most species collected were rough and/or forage species. Few sport fish were collected (Table D.6-1).

- Random inspection of fish taken from the discharge area indicated no evidence of early gonad maturation.

D.6-7. Significance and Critique of Findings

- Resident finfish species are attracted to the R.P. Smith discharge in winter months and the potential for mortalities due to cold-shock, in the event of plant shutdown, exists.

- No analyses were completed by MDNR on catches, mean lengths, or mean weights, but it appears that all species present in winter months are attracted to the plume. No differences in mean length or weight are apparent for species collected in both heated and non-heated areas.

Table D.6-1. Summary of electrofishing samples below R.P. Smith power plant, February 23 (1st sample) and March 16, 1979 (2nd sample)(from Ref. 9).

Fish Species	Trn-1 MD 1st	Trn-1 MD 2nd	Trn-1 WVA 1st	Trn-1 WVA 2nd	Trn-2 MD* 1st	Trn-2 MD* 2nd	Trn-2 WVA 1st	Trn-2 WVA 2nd	Trn-3-MD 1st	Trn-3-MD 2nd	Trn-3 WVA 1st	Trn-3 WVA 2nd
Cyprinus carpio	13	1	0	0	4	8	0	3	2	0	0	0
Mean length**	57.1	64.5			59.2	58.8		58.9	55.4			
Mean weight†	1789	4000			2154	3000		2900	1701			
Catostomus commersoni	3	5	0	0	1	2	0	1	1	0	0	1
Mean length	39.7	36.0			36.2	37.8		38.0	37.8			42.2
Mean weight	663	542			477	611		642	578			1041
Moxostoma erythrurum	33	78	1	22	60	39	0	35	137	0	0	23
Mean length	38.5	33.1	36.6	39.2	37.4	37.5		38.8	37.0			38.0
Mean weight	588	419	543	654	566	595		625	521			587
Moxostoma macrolepidotum	7	3	1	2	16	9	0	4	42	0	0	5
Mean length	39.4	27.4	40.0	38.2	40.7	42.6		42.1	41.2			40.8
Mean weight	604	510	660	600	714	784		726	688			730
Hypentelium nigraicans	2	0	1	0	0	0	1	0	0	0	0	0
Mean length	29.9		21.5				32.6					
Mean weight	322		105				401					
Micropterus dolomieui	0	0	0	0	0	0	0	0	1	0	0	1
Mean length									19.4			24.8
Mean weight									99			155
Micropterus salmoides	0	1	0	0	0	0	0	0	0	0	0	0
Mean length		27.8										
Mean weight		300										
Carassius auratus		1										
Semotilus corporalis												2
Notropis amoenus								2				
Notropis rubellus								2				
Anguilla rostrata												1

* 7 1/2 min
** All lengths measured in centimeters
† All weights measured in grams

APPENDIX D.7. FINFISH CONDITION STUDY - SUMMER 1979 AND WINTER 1980

(TI)

D.7-1. Objective

To determine the effects of the R.P. Smith Steam Electric Station thermal plume on the weight-length relationships of six selected finfish species (spotfin shiner, golden redhorse, channel catfish, redbreast sunfish, smallmouth bass, and carp).

D.7-2. Data Source

Ref. 2.

D.7-3. Study History

Samples were collected on three nonconsecutive dates between July 25 to August 8, 1979 and on six nonconsecutive dates between January 15 to 28, 1980.

D.7-4. Sampling Methods

- Six sampling transects (Figure D.7-1) were established in the study area; three within the plume generated by the R.P. Smith power station [outfall test(T3), intermediate plume test (T4), and farfield plume test (T5)] and three outside the plume [two upstream (T1 and T2) and one downstream (T8)]. Two stations were established on opposite sides of the river at each transect for comparative purposes. The Maryland side of the Potomac River is considered the right shore or bank; the West Virginia side, the left shore or bank.

- Finfish were sampled on 3 nonconsecutive days during the summer of 1979 (July 25 - August 8) and 6 nonconsecutive days during the winter of 1980 (January 15 - 28).

- Transects 1 through 5 and 8 were sampled during the summer of 1979 and transects 1 through 7 during the winter of 1980.

- Finfish were collected along a 300-foot run at each station with a pulse dc, boat-mounted electrofishing unit. Each 300-foot run was considered one unit of effort.

- Beach seine collections were made along both shores during the summer of 1979 and winter of 1980. All samples were collected with a 6 x 6 ft, 1/8-in. bar mesh bag seine in areas free from underwater obstructions. At each station, seining consisted of one onshore haul; each haul was considered as one unit of effort.

- Six Representative Important Species (RIS) were selected for detailed analysis: channel catfish, golden redhorse, spotfin shiner, redbreast sunfish, smallmouth bass, and carp. Total length (millimeters) and weight (grams) of each fish were measured for up to 25 individuals per species per catch.

- At each sampling location, temperature (C), dissolved oxygen concentration (milligrams per liter), and stream flow (meters per second) were recorded.

D.7-5. Analysis

- Length and weight data for individuals of the selected species were grouped by location of capture. Length-wise relationships for each target species at each site (i.e., upstream control, affected region, downstream control) were calculated from the logarithms (base 10) of the lengths and weights using the equation:

$$\log W = A + B \log (T6)$$

where

W = weight in grams

A and B = empirically derived constants

TL = total length in mm.

- Condition factors (K) were also calculated for these same groups of fish by length class using the equation

$$K_{(TL)} = \frac{W \times 10^5}{L^3}$$

where

W = weight in grams

L = total length in millimeters.

- Levene's test was used to test the equality of variances among sites.

- If the variances were homogeneous, an ANCOVA test for common slopes (b) across sites was implemented. When the variances were heterogeneous, inferences were restricted. However, the tests for common slopes were made and only the extremely large or small probability values were used in rejecting or accepting the hypothesis of common slopes.

D.7-6. Results

- Temperatures observed during electrofishing are shown in Tables D.7-1 and D.7-2.

- Golden redhorse collected by electrofishing within the study area ranged in total length from approximately 121 to 500 mm. The average total lengths of fish collected within the upstream and downstream control areas during both summer and winter were larger than those collected in the thermally affected area (Table D.7-3). Condition factors (K) for fish captured by seine were similar among sites (Table D.7-3).

- Covariance analyses comparing the allowable equations for golden redhorse among sites in summer revealed that the slopes were significantly different ($P < 0.05$, Table D.7-4) indicating that golden redhorse in the control area weighed more for a given length than golden redhorse from the thermally affected area.

- During winter, weight-length relationships for golden redhorse among the three sites -- upstream control, thermally affected area, and downstream control (Transects 6 and 7) -- were not significantly different (Table D.7-5).

- The total length range of spotfin shiner in the upstream control and in the thermally affected areas were similar (Table D.7-6). During winter, average total length of spotfin shiner was greatest in the upstream control area. Average lengths between upstream control and thermally affected areas appeared to be similar during summer. Condition factors for both summer and winter appeared to be similar.

- Comparison of spotfin shiner growth relationships between upstream control and thermally affected areas (Table D.7-7) showed homogeneous variability between sites in summer. Growth relationships were similar among sites.

- The weight-length relationships for spotfin shiner sampled in winter from upstream and downstream control sites and the area influenced by the thermal discharge had unequal variances and, therefore, could not be statistically compared (Table D.7-8).

- Condition factors (K) for smallmouth bass were similar among sites for both summer and winter (Table D.7-9).

- Weight relationships calculated for smallmouth bass were of limited value due to the low numbers of fish collected. No significant differences (Tables D.7-10 and D.7-11) were observed.

- Average total lengths of redbreast sunfish were similar among sites that could be compared during summer and winter. The condition factor was higher for the upstream control than for the thermally affected area during summer and higher for the thermally affected area than for the downstream control during winter (Table D.7-12).

- Covariance analyses showed weight-length relationships for redbreast sunfish specimens were similar in summer and winter (Tables D.7-13 and D.7-14).

- Mean total lengths of channel catfish in the upstream control area were higher than those from the thermally affected areas for both summer and winter (Table D.7-15).

- The weight-length relationships (summer) for channel catfish between the upstream control and thermally affected sites were not significantly different (Table D.7-16).

- Condition factors (K) for carp were larger during summer at the thermally influenced site than at the control site. During winter, condition factors were highest for carp collected at the downstream control area and lowest at the upstream control (Table D.7-17). Mean lengths were smallest for carp collected within the thermally influenced area and largest for fish from either upstream or downstream control areas.

- Weight-length relationships for carp during winter were significantly different at the three sites (Table D.7-18). Because only a few carp, covering a small range of length, were used for the downstream regression, small sample size, rather than any effects due to thermal influence, probably was the reason the equations were significantly different.

D.7-7. Significance and Critique of Findings

- Since stations [unheated (West Virginia shore) and heated (Maryland shore)] within thermally affected transects (Transects 3, 4, 5, and 8) were pooled, it is difficult to conclude whether the difference in regressions was due to the thermal discharge or to habitat differences between transects. Only significant differences showing decreased condition at the thermally affected site indicate a viable conclusion. Because of cross-stream data lumping, the lack of significant differences among sites does not conclusively mean no effect due to the thermal discharge.

- In addition, because transects were lumped, these analyses do not represent a conclusive indication of the effect of ΔT levels on finfish condition.

- Golden redhorse condition appears to be adversely affected by the thermal discharge.

Table D.7-1. Potomac River water temperature (C) measured during electrofishing excursions, R.P. Smith SES, July - August 1979.

Date	1L	1R	2L	2R	3L	3R	4L	4R	5L	5R	8L	8R
7/30	24.0	24.0	24.0	24.0	26.0	28.0	26.0	28.5	26.0	26.0	26.0	27.0
8/3	28.5	28.5	27.5	27.5	25.9	31.5	26.1	31.5	26.5	26.5	27.8	28.8
8/6	29.0	29.0	29.0	29.0	29.2	34.5	27.5	32.0	28.0	28.0	29.0	31.0

Table D.7-2. Potomac River water temperature (C) measured during electrofishing excursions, R.P. Smith SES, January 1980.

Date	1L	1R	2L	2R	3L	3R	4L	4R	5L	5R	6L	6R	7L	7R
1/18	4.1	4.0	4.1	4.1	4.1	9.8	4.1	6.5	4.1	5.2	4.1	4.7	4.0	4.5
1/20	3.9	4.0	4.1	4.0	4.1	7.9	4.3	5.8	4.0	5.0	4.1	4.1	4.0	4.3
1/22	3.1	3.0	3.1	3.1	3.1	8.0	3.2	5.2	4.1	4.1	4.1	4.2	3.9	4.0
1/24	0.8	2.0	1.9	2.0	2.0	8.2	2.0	4.9	2.0	5.0	2.0	2.2	2.0	2.2
1/26	0.9	1.0	0.9	1.0	0.9	11.8	0.8	7.1	1.0	4.0	2.1	1.8	1.5	2.1
1/28	0.7	0.8	0.8	0.9	1.0	10.8	1.2	8.6	1.2	5.0	2.8	1.8	1.6	2.8

Table D.7-3. Condition factor (K) and frequency distribution of selected species caught in the vicinity of R.P. Smith plant.

GEAR=ELECTROFISHING SITE=UPSTREAM CONTROL SPECIES=GOLDEN REDHORSE

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
41	50	0.8	1.0	.	.
121	130	1.1	1.0	.	.
141	150	1.2	1.0	.	.
151	160	1.2	1.0	.	.
181	190	0.7	1.0	.	.
231	240	1.2	1.0	.	.
251	260	1.0	5.0	.	.
261	270	1.2	3.0	.	.
271	280	1.0	1.0	.	.
281	290	1.1	3.0	.	.
291	300	1.0	2.0	.	.
301	310	1.1	3.0	.	.
311	320	1.0	2.0	1.0	1.0
321	330	0.9	3.0	.	.
331	340	1.0	4.0	0.9	2.0
341	350	1.2	1.0	1.0	2.0
351	360	0.9	2.0	0.9	3.0
361	370	1.0	3.0	1.0	4.0
371	380	1.0	7.0	1.0	4.0
381	390	.	.	1.1	2.0
391	400	.	.	0.9	2.0
411	420	1.3	1.0	.	.
431	440	0.4	1.0	.	.
461	470	.	.	1.2	1.0
AVERAGE		1.0	302.2	1.0	367.8
# MEASURED		47.0	47.0	21.0	21.0

GEAR=ELECTROFISHING SITE=THERMALLY AFFECTED AREA SPECIES=GOLDEN REDHORSE

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
131	140	1.1	1.0	.	.
141	150	1.1	1.0	.	.
151	160	1.2	3.0	.	.
161	170	1.1	3.0	1.2	1.0
171	180	1.1	2.0	.	.
191	200	.	.	1.2	1.0
231	240	1.0	2.0	.	.
241	250	1.0	6.0	1.3	4.0
251	260	1.0	7.0	.	.
261	270	1.0	8.0	1.0	2.0
271	280	1.0	4.0	1.1	4.0
281	290	1.0	7.0	1.1	11.0
291	300	1.0	9.0	1.0	15.0
301	310	1.0	8.0	1.1	12.0
311	320	1.0	10.0	1.0	26.0
321	330	0.9	7.0	1.0	18.0
331	340	1.0	19.0	1.0	17.0
341	350	0.9	19.0	1.0	18.0
351	360	0.9	10.0	1.0	16.0
361	370	0.9	15.0	1.0	18.0
371	380	0.9	7.0	1.0	11.0
381	390	0.9	11.0	1.1	9.0
391	400	0.9	4.0	0.9	10.0
401	410	0.8	3.0	1.2	5.0
411	420	.	.	1.3	3.0
421	430	1.1	1.0	.	.
431	440	0.8	2.0	1.0	1.0
451	460	1.1	4.0	.	.
491	500	0.7	1.0	.	.
AVERAGE		1.0	324.0	1.0	335.5
# MEASURED		174.0	174.0	202.0	202.0

GEAR=ELECTROFISHING SITE=DOWNSTREAM CONTROL SPECIES=GOLDEN REDHORSE

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
191	200	.	.	1.0	1.0
251	260	.	.	1.1	1.0
281	290	.	.	1.2	1.0
311	320	.	.	1.1	2.0
321	330	.	.	1.2	7.0
331	340	.	.	1.0	14.0
341	350	.	.	1.0	8.0
351	360	.	.	1.0	8.0
361	370	.	.	1.0	19.0
371	380	.	.	1.0	10.0
381	390	.	.	1.0	7.0
391	400	.	.	0.9	3.0
401	410	.	.	0.9	1.0
411	420	.	.	1.0	1.0
431	440	.	.	1.2	1.0
441	450	.	.	1.3	1.0
471	480	.	.	1.0	1.0
AVERAGE		.	.	1.0	357.5
# MEASURED		.	.	86.0	86.0

Table D.7-4. Summer length-weight regressions of golden redhorse (from Ref. 2).

ANALYSIS OF POOLED DATA

GROUP	A	S.E. A	95 PERCENT C.I. A	B	S.E. B	95 PERCENT C.I. B	SAMPLE SIZE	ERROR MEAN SQUARE
1	-4.946884	.1700843	-5.289455 -4.604312	2.976040	.6903712D-01	2.836990 3.115090	47	.5834770D-02
2	-4.442431	.1159135	-4.671727 -4.213135	2.769888	.4637116D-01	2.678158 2.861617	134	.3346298D-02
MEAN	-4.667584	.9420743D-01	-4.853491 -4.481677	2.860656	.2811834D-02	2.855107 2.866205	181	.3978960D-02

NOTE THAT THE ABOVE M.S. ERROR FOR THE POOLED LINE IS DERIVED FROM THE POOLED WITHIN LINE ERROR.

LEVENE'S TEST STATISTIC FOR THE EQUALITY OF THE GROUP VARIANCES IS

F(1, 179) = 2.38926

PROBABILITY OF A LARGER F VALUE IS
P = 0.1239

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	MEAN SQUARE	F RATIO	PR > F
COMMON LINE	2	.303026356641D-01	.151513178210D-01	3.307859	0.0240
COMMON SLOPE	1	.291199551220D-01	.291199551220D-01	7.318484	0.0075
SLOPE OF GROUP MEANS VERSUS AVERAGE WITHIN GROUP SLOPE	1	.11826805196D-02	.11826805196D-02	.2972336	0.5863
ERROR	177	.70427596141	.39789602339D-02		
COMMON INTERCEPT (ASSUMES A COMMON SLOPE)	1	.11826805196D-02	.11826805196D-02	.2870443	0.59279
ERROR	178	.73339591653	.41202017783D-02		
REGRESSION ABOUT THE OVERALL LINE	1	23.140510235	23.140510235	5638.813	0.0000
RESIDUAL ABOUT THE OVERALL LINE	179	.73457859705	.41037910450D-02		
TOTAL	180	23.875088832			

Table D.7-5. Winter length-weight regressions of golden redhorse (from Ref. 2).

ANALYSIS OF POOLED DATA

GROUP	A	S.E. A	95 PERCENT C.I. A	B	S.E. B	95 PERCENT C.I. B	SAMPLE SIZE	ERROR MEAN SQUARE
1	-6.075036	.4664780	-7.051394 -5.098677	3.416729	.1818994	3.036005 3.797452	21	.7683310D-03
2	-4.455608	.1860507	-4.822500 -4.088717	2.788617	.7373270D-01	2.643216 2.934018	202	.3350264D-02
3	-4.358636	.2983148	-4.951881 -3.765391	2.750788	.1169227	2.518269 2.983307	86	.2475307D-02
MEAN	-4.479959	.1518259	-4.777538 -4.182380	2.798045	.3408576D-02	2.791364 2.804726	309	.2945798D-02

NOTE THAT THE ABOVE M.S. ERROR FOR THE POOLED LINE IS DERIVED FROM THE POOLED WITHIN LINE ERROR.

LEVENE'S TEST STATISTIC FOR THE EQUALITY OF THE GROUP VARIANCES IS

F(2, 306) = 2.03556

PROBABILITY OF A LARGER F VALUE IS
P = 0.1324

ANALYSIS OF VARIANCE FOR REGRESSION LINES

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	MEAN SQUARE	F RATIO	PR > F
COMMON LINE	4	.10983514368D-01	.27458785920D-02	.9321339	0.4591
COMMON SLOPE	2	.93475179430D-02	.46737589715D-02	1.586585	0.2063
SLOPE OF GROUP MEANS VERSUS AVERAGE WITHIN GROUP SLOPE	1	.42061420069D-03	.42061420069D-03	.1427844	0.7058
GROUP MEANS ABOUT THEIR REGRESSION LINE	1	.12153822243D-02	.12153822243D-02	.4125816	0.5211
ERROR	303	.89257693312	.29457984591D-02		
COMMON INTERCEPT (ASSUMES A COMMON SLOPE)	2	.16359964250D-02	.81799821251D-03	.2766190	0.75853
ERROR	305	.90192445106	.29571293477D-02		
REGRESSION ABOUT THE OVERALL LINE	1	6.9378391177	6.9378391177	2357.249	0.0000
RESIDUAL ABOUT THE OVERALL LINE	307	.90356044749	.29431936400D-02		
TOTAL	308	7.8413995652			

Table D.7-6. Condition factor (K) and frequency distribution of spotfin shiner caught in the vicinity of R.P. Smith plant (from Ref. 2).

GEAR=SEINES SITE=UPSTREAM CONTROL SPECIES=SPOTFIN SHINER

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
11	20	.	.	1.2	1.0
21	30	0.7	2.0	0.7	23.0
31	40	0.6	16.0	0.6	57.0
41	50	0.7	29.0	0.7	43.0
51	60	0.9	23.0	0.7	36.0
61	70	0.9	15.0	0.6	6.0
71	80	1.0	9.0	.	.
81	90	1.1	4.0	.	.
AVERAGE		0.8	53.6	0.7	41.9
# MEASURED		98.0	98.0	166.0	166.0

GEAR=SEINES SITE=THERMALLY AFFECTED AREA SPECIES=SPOTFIN SHINER

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
11	20	2.4	1.0	.	.
21	30	0.6	4.0	0.7	11.0
31	40	0.6	1.0	0.7	17.0
41	50	0.7	59.0	0.6	11.0
51	60	0.7	100.0	0.6	3.0
61	70	0.9	36.0	0.6	2.0
71	80	0.9	15.0	.	.
81	90	1.1	1.0	.	.
AVERAGE		0.8	55.3	0.7	38.8
# MEASURED		217.0	217.0	44.0	44.0

GEAR=SEINES SITE=DOWNSTREAM CONTROL SPECIES=SPOTFIN SHINER

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
11	20	.	.	1.4	2.0
21	30	.	.	0.7	41.0
31	40	.	.	0.5	54.0
41	50	.	.	0.5	6.0
61	70	.	.	0.6	1.0
71	80	.	.	0.7	1.0
AVERAGE		.	.	0.6	32.4
# MEASURED		.	.	105.0	105.0

Table D.7-7. Summer weight-length regressions of spotfin shiner (from Ref. 2).

ANALYSIS OF POOLED DATA

GROUP	A	S.E. A	95 PERCENT C.I. A	B	S.E. B	95 PERCENT C.I. B	SAMPLE SIZE	ERROR MEAN SQUARE
1	-6.110247	.1434577	-6.395016 -5.825479	3.584835	.8349989D-01	3.419085 3.750586	98	.9135490D-02
2	-5.146604	.1585938	-5.461546 -4.831663	3.020372	.9202000D-01	2.837636 3.203109	95	.8444002D-02
MEAN	-5.695021	.1062347	-5.904573 -5.485468	3.340895	.4444029D-02	3.332129 3.349661	193	.8795234D-02

NOTE THAT THE ABOVE M.S. ERROR FOR THE POOLED LINE IS DERIVED FROM THE POOLED WITHIN LINE ERROR.

LEVENE'S TEST STATISTIC FOR THE EQUALITY OF THE GROUP VARIANCES IS

F(1, 191) = .133044D-02

PROBABILITY OF A LARGER F VALUE IS
P = 0.9709

ANALYSIS OF VARIANCE FOR REGRESSION LINES

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	MEAN SQUARE	F RATIO	PR > F
COMMON LINE	2	.18212174631	.91060873155D-01	10.35343	0.0001
COMMON SLOPE	1	.18041767468	.18041767468	20.51312	0.0000
SLOPE OF GROUP MEANS VERSUS AVERAGE WITHIN GROUP SLOPE	1	.17040716322D-02	.17040716322D-02	.1937494	0.6603
ERROR	189	1.6622992072	.87952339005D-02		
COMMON INTERCEPT (ASSUMES A COMMON SLOPE)	1	.17040716322D-02	.17040716322D-02	.1757045	0.67557
ERROR	190	1.8427168819	.96985099046D-02		
REGRESSION ABOUT THE OVERALL LINE	1	25.764131307	25.764131307	2668.018	0.0000
RESIDUAL ABOUT THE OVERALL LINE	191	1.8444209535	.96566542068D-02		
TOTAL	192	27.608552260			

Table D.7-8. Winter length-weight regressions of spotfin shiner (from Ref. 2).

ANALYSIS OF POOLED DATA

GROUP	A	S.E. A	95 PERCENT C.I. A	B	S.E. B	95 PERCENT C.I. B	SAMPLE SIZE	ERROR MEAN SQUARE
1	-5.285173	.1288018	-5.539508 -5.030838	3.067738	.7991023D-01	2.909946 3.225531	166	.1296326D-01
2	-5.099977	.1840258	-5.471359 -4.728594	2.939912	.1165959	2.704610 3.175214	44	.7845782D-02
3	-4.509753	.2214839	-4.949024 -4.070483	2.512005	.1473832	2.219699 2.804311	105	.1914733D-01
MEAN	-5.053586	.1006707	-5.250901 -4.856271	2.906175	.3610967D-02	2.899098 2.913253	315	.1432904D-01

NOTE THAT THE ABOVE M.S. ERROR FOR THE POOLED LINE IS DERIVED FROM THE POOLED WITHIN LINE ERROR.

LEVENE'S TEST STATISTIC FOR THE EQUALITY OF THE GROUP VARIANCES IS

F(2, 312) = 3.76840

PROBABILITY OF A LARGER F VALUE IS
P = 0.0241

ANALYSIS OF VARIANCE FOR REGRESSION LINES

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	MEAN SQUARE	F RATIO	PR > F
COMMON LINE	4	.49504971623	.12376242906	8.637176	0.0000
COMMON SLOPE	2	.19060201381	.95301006907D-01	6.650901	0.0015
SLOPE OF GROUP MEANS VERSUS AVERAGE WITHIN GROUP SLOPE	1	.30426310755	.30426310755	21.23402	0.0000
GROUP MEANS ABOUT THEIR REGRESSION LINE	1	.18459486972D-03	.18459486972D-03	.1288257D-01	0.9097
ERROR	309	4.4276727218	.14329037935D-01		
COMMON INTERCEPT (ASSUMES A COMMON SLOPE)	2	.30444770242	.15222385121	10.25093	0.00005
ERROR	311	4.6182747356	.14849757992D-01		
REGRESSION ABOUT THE OVERALL LINE	1	38.961720562	38.961720562	2477.292	0.0000
RESIDUAL ABOUT THE OVERALL LINE	313	4.9227224380	.15727547725D-01		
TOTAL	314	43.884443001			

Table D.7-9. Condition factor (K) and frequency distribution of smallmouth bass caught in the vicinity of R.P. Smith plant (from Ref. 2).

GEAR=ELECTROFISHING SITE=UPSTREAM CONTROL SPECIES=SMALLMOUTH BASS

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
131	140	1.4	1.0	.	.
141	150	0.8	1.0	.	.
171	180	0.9	1.0	.	.
221	230	1.6	1.0	.	.
341	350	.	.	1.3	1.0
AVERAGE		1.2	171.5	1.3	342.0
# MEASURED		4.0	4.0	1.0	1.0

GEAR=ELECTROFISHING SITE=THERMALLY AFFECTED AREA SPECIES=SMALLMOUTH BASS

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
41	50	1.3	1.0	.	.
71	80	.	.	1.4	1.0
81	90	.	.	0.9	1.0
111	120	1.1	1.0	.	.
121	130	1.1	1.0	.	.
131	140	1.1	3.0	.	.
141	150	0.9	1.0	.	.
151	160	1.2	2.0	0.0	1.0
161	170	1.0	2.0	.	.
171	180	1.0	1.0	1.5	1.0
181	190	1.1	3.0	.	.
191	200	1.1	2.0	.	.
201	210	1.1	1.0	1.2	2.0
221	230	1.2	1.0	.	.
231	240	1.2	1.0	1.2	2.0
241	250	.	.	1.1	1.0
251	260	.	.	1.2	5.0
261	270	.	.	1.2	1.0
271	280	.	.	1.3	3.0
461	490	0.8	1.0	.	.
AVERAGE		1.1	178.2	1.2	221.2
# MEASURED		21.0	21.0	18.0	18.0

GEAR=ELECTROFISHING SITE=DOWNSTREAM CONTROL SPECIES=SMALLMOUTH BASS

RANGEMIN	RANGEMAX	SUMMER_K	SUM_FREQ	WINTER_K	WIN_FREQ
61	70	.	.	1.0	1.0
121	130	.	.	0.7	1.0
261	270	.	.	1.2	1.0
341	350	.	.	1.2	1.0
411	420	.	.	1.5	1.0
AVERAGE		.	.	1.1	243.6
# MEASURED		.	.	5.0	5.0

Table D.7-10. Summer length-weight regressions of smallmouth bass (from Ref. 2).

ANALYSIS OF POOLED DATA

GROUP	A	S.E. A	95 PERCENT C.I. A	B	S.E. B	95 PERCENT C.I. B	SAMPLE SIZE	ERROR MEAN SQUARE
1	-6.399009	1.985435	-14.94163 2.143613	3.652241	.8917543	-.1846622 7.489144	4	.2598251D-01
2	-4.536200	.1258675	-4.820934 -4.251467	2.800751	.5732309D-01	2.671077 2.930426	11	.2027063D-02
MEAN	-4.621794	.2184641	-5.093758 -4.149830	2.843581	.2559424D-01	2.788288 2.898875	15	.6332600D-02

NOTE THAT THE ABOVE M.S. ERROR FOR THE POOLED LINE IS DERIVED FROM THE POOLED WITHIN LINE ERROR.

LEVENE'S TEST STATISTIC FOR THE EQUALITY OF THE GROUP VARIANCES IS

F(1, 13) = 23.6543

PROBABILITY OF A LARGER F VALUE IS
P = 0.0003

ANALYSIS OF VARIANCE FOR REGRESSION LINES

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	MEAN SQUARE	F RATIO	PR > F
COMMON LINE	2	.250531584190D-01	.125265792100D-01	1.962614	0.1867
COMMON SLOPE	1	.224975705230D-01	.224975705230D-01	3.524829	0.0872
SLOPE OF GROUP MEANS VERSUS AVERAGE WITHIN GROUP SLOPE	1	.255558789620D-02	.255558789620D-02	.4003992	0.5398
ERROR	11	.702085967820D-01	.638259970750D-02		
COMMON INTERCEPT (ASSUMES A COMMON SLOPE)	1	.255558789620D-02	.255558789620D-02	.3307984	0.57582
ERROR	12	.927061673050D-01	.772551394210D-02		
REGRESSION ABOUT THE OVERALL LINE	1	5.3141084200	5.3141084200	725.1956	0.0000
RESIDUAL ABOUT THE OVERALL LINE	13	.952617552010D-01	.732782732320D-02		
TOTAL	14	5.4093701752			

Table D.7-11. Winter length-weight regressions of smallmouth bass (from Ref. 2).

ANALYSIS OF POOLED DATA

GROUP	A	S.E. A	95 PERCENT C.I. A	B	S.E. B	95 PERCENT C.I. B	SAMPLE SIZE	ERROR MEAN SQUARE
1	2.707570	.0	2.707570 2.707570	.0	.0	.0 .0	1	.0
2	-4.990597	.1503191	-5.310996 -4.670198	3.034242	.6441670D-01	2.896941 3.171543	17	.1976002D-02
3	-5.596933	.3930389	-6.847763 -4.346103	3.272111	.1693541	2.733149 3.811074	5	.1243016D-01
MEAN	-5.267150	.1539129	-5.587231 -4.947069	3.147580	.1371826D-01	3.119051 3.176109	23	.3937089D-02

NOTE THAT THE ABOVE M.S. ERROR FOR THE POOLED LINE IS DERIVED FROM THE POOLED WITHIN LINE ERROR.

LEVENE'S TEST STATISTIC FOR THE EQUALITY OF THE GROUP VARIANCES IS

F(2, 20) = 2.10347

PROBABILITY OF A LARGER F VALUE IS
P = 0.1482

ANALYSIS OF VARIANCE FOR REGRESSION LINES

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	MEAN SQUARE	F RATIO	PR > F
COMMON LINE	4	.24867099288D-01	.62167748221D-02	1.579028	0.2252
COMMON SLOPE	2	.12838183289D-01	.64190916444D-02	1.630416	0.2250
SLOPE OF GROUP MEANS VERSUS AVERAGE WITHIN GROUP SLOPE	1	.56775650000D-03	.56775650000D-03	.1442072	0.7088
GROUP MEANS ABOUT THEIR REGRESSION LINE	1	.11461159499D-01	.11461159499D-01	2.911075	0.1062
ERROR	17	.66930511258D-01	.39370888975D-02		
COMMON INTERCEPT (ASSUMES A COMMON SLOPE)	2	.12028915999D-01	.60144579997D-02	1.432576	0.26334
ERROR	19	.79768694546D-01	.41983523445D-02		
REGRESSION ABOUT THE OVERALL LINE	1	9.4963573877	9.4963573877	2172.426	0.0000
RESIDUAL ABOUT THE OVERALL LINE	21	.91797610546D-01	.43713147879D-02		
TOTAL	22	9.5881549982			